Growth and Gut Content of the Madeiran sardinella (*Sardinella Maderensis)* from Abonnema Creek, Rivers State, Nigeria

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Abstract
The growth and Food of Sardinella maderensis from Abonnema Creek was conducted to generate relevant data on the species. Length-weight measurements subjected to regression analysis revealed a negative allometric growth of (2.4767±0.0619). Fulton's condition factor (k) was determined by the relationship k= W100/L^3, the fish condition factor was 2.2194±0.14903. Data obtained from the fish gut was analysed using point method and frequency of occurrence. The food found in the fish gut was ranked for importance using the index of food significance (IFS), The following were found in the gut of S mederensis: (Melosiraceae)Melosira distans, Melosira varians, Melosira italic, Melosira granulate, (Stephanodicaceae) Cyclotella comate, Cyclotella atomus, Cyclotella ocellata, Cyclotella opeculata, (Coscinodiscaceae) Cosinodiscus lacustris, (Pinnulariaceae) Pinularia sp, (Fragilariaceae) Synedria tabutata, Synadria ulna, Fragilaria venecens, Fragineria capusina, (Tabellariaceae) Tabellaria flocullosa. The study revealed that the most important food consumed by the bigger fishes (13.0 – 13.5cm) was Melosira distans (13.48) while the small group (9.0 – 12.0cm) was Synedria tabutata (10.89). The species was predominantly an algae feeder and would do well on moderate to low protein feed if held in captivity.

Key words: *Clupeids, allometry, Growth, Food, habits.*

Introduction

Numerous studies have used a variety of techniques, including stomach content analysis, stable isotope analysis, and fatty acid analysis, to examine the feeding ecology of *S. maderensis* in diverse settings. Copepods are the primary food source for *S. maderensis* in Abonnema Creek, Nigeria, these foods include diatoms and dinoflagellates (Ikeogu et al., 2019). On the other hand, *S. maderensis* in the Gulf of Guinea consumes a variety of prey items such asas copepods, euphausiids, amphipods, and fish larvae (Froese and Pauly, 2019). Depending on the availability of prey and the surrounding conditions, *S. maderensis* might have varying seasonal and spatial food habits. *S. maderensis*, for instance, feeds on copepods during the upwelling season in the Canary Current upwelling system and consumes more of dinoflagellates and diatoms during the non-upwelling season (Bode et al.,2016). During the austral winter, *S. maderensis* in the Benguela upwelling system feeds on copepods; in the austral summer, it switches to euphausiids and fish larvae (van der Lingen et al., 2006).

Fish growth is considered an integrative physiological response that takes into account both the internal physiological status (health, stress, and reproductive state) of fish as well as the external environmental factors (temperature, water quality, and amount and quality of food) (NOAA, 2023). Growth comprises a rise in body size over time, including weight, length/height, and organ size (Graber, 2023). Two crucial tools for fishery management are the length-weight relationship (LWR) and the condition factor (Fulton's K) (Uneke 2016). By estimating the standing stock biomass and comparing the ontogeny of fish from different regions, the LWR relationship allows for comparisons of species growth between different regions and provides information on the relative wellbeing of the fish population. It also determines whether somatic growth is isometric or allometric. Fish welfare is compared on the concept that fishthat have more weight per length have better physiological condition (Hart and Abowei, 2009). This is known as the condition factor.

This study aims to provide key data necessary for a successful rearing of *S. maderensis*in captivity by providing important information on its feeding habits and growth.

Materials and Methods

The research was conducted in Nigeria's Abonnema Creek Rivers State. A wide variety of aquatic life, including fish, crabs, shrimp, and different aquatic plants like nypa palm (*Nypa fructican*), can be found in the brackish stream. Its coordinates are 04.51'N and 07.01'E, respectively, for latitude and longitude.
Over the course of three months, samples of *Sardinella maderensis* were collected in clean plastic buckets every two weeks from randomly chosen fisherman in the Abonnema Creek area. At the point of collection, the samples were stored in 10% formaldehyde solution and promptly sent to the laboratory for examination.

Length-Weight Determination

The growth coefficients length/weight relationship (LWR) was determined by the use of the formula below:
$W=aL^b$ regression
Where,
W= Weight of the Fish (grams)
a= Intercept of the regression
L= Observed Total length (cm)
b= Slope of the regression line (Growth coefficient)
The growth coefficients of the length-weight (LWR) was further deduced to logarithm form:
LogW = Log a + Log L
The condition factor (K) was calculated using:

$$K = \frac{100W}{L^3}$$

(Chukwu and Pepple 2021).
Where:
W= Weight (grams)
L= Observed Total length (cm)
K= Condition Factor

The following techniques were used to evaluate the stomach content:

Points method:

Points were awarded to various food items based on their quantity (size) in relation to the other, this was expressed as follows:

$$\text{Percentage by number (\%N)} = \frac{\text{Total Points of the particular food item}}{\text{Total Points of all food items}} \times 100$$ (Ezenwaji and Offiah, 2003)

Frequency of Occurrence Method

Frequency of occurrence of each diet was expressed as:

$$\text{\% Occurence of the food item} = \frac{\text{Total Number of stomachs with the particular food item}}{\text{Total number of stomachs with food}} \times 100$$

(Ezenwaji and Offiah, 2003; Chukwu and Princewill, 2019)

Index of Food Significance (IFS)

$IFS = \frac{\%F \times \%P}{\sum \%F \times \%P} \times 100$ (Ezenwaji and Offiah, 2003; Chukwu and Oyanna 2022) Where,

IFS= Index of Food Significance

%F= Percentage frequency of occurrence of food item.

%P= Percentage Number of food item.

Food with IFS ≥ 3% will be regarded as primary, ≥ 0.1 to <3% as secondary, whereas, food with <0.1% will be regarded as incidental (Vandi *et al*., 2019).

RESULTS

The samples ranged from 9.0cm to 13.5cm across period of collection (n = 210). Growth analysis of *Sardinella maderensis* from AbonnemaCreek showed the b-values of the fish negative allometric (2.4767±0.0619), an intercept value (a) of -0.256±0.00464, and correlation coefficient (R^2) of the length/weight was 0.8843. The overall value of the condition factor recorded after calculation was 2.2194±0.14903. Monthly condition factor was highest in May and had its lowest dip in July (Figure 1)

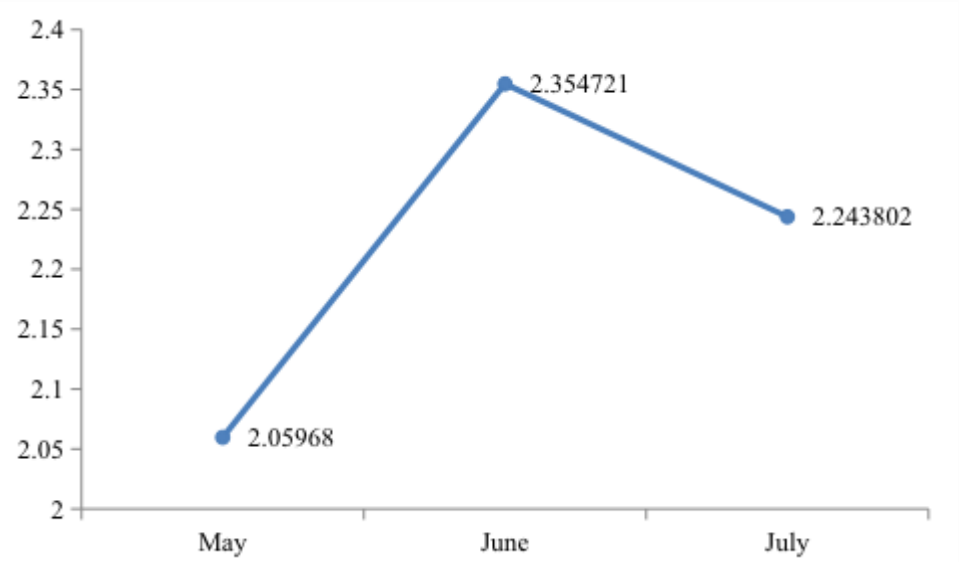

Figure 1: Monthly condition factor of *S. maderensis* from Abonnema Creek

A total of 6 families (Melosiraceae, Stephanodicaceae, Cosinodiscaceae, Pinnulariaceae, Fragilariaceae and Tabellariaceae), 8 genera (*Melosira, Cyclotella, Cosinodicus, Pinularia, Synedria, Synadria, Fragilaria* and *Tabellaria*) and 15 species (*Melosiradistans, Melosiravarians, Melosira italica, Melosiragranulata, Cyclotella comata, Cyclotella atomus, Cyclotella ocellata, Cyclotella opeculata, Cosinodiscuslacustris, Pinulariasp, Synedria tabutata, Synadria ulna, Fragilaria venecens, Fragineriacapusina and Tabellariaflocullosa*) of food items were found in the stomach of *Sardinella maderensis* across all size ranges (Tables 1 and 2). The study revealed that the most important food consumed by the bigger fishes (13.0 – 13.5cm) was *Melosiradistans*(13.48) while the small group (9.0 – 12.0cm) was *Synedria tabutata*(10.89).

Table 1: Stomach content of *Sardinella maderensis* (9.0cm-12cm)

Food Item	%RF	%Point	IFS	%IFS
Family: Melosiraceae				
Melosira distans	6.48	11.48	74.39	10.71
Melosira varians	6.48	6.13	39.72	5.71
Melosira italica	6.48	9.75	63.18	9.10
Melosira granulata	8.33	11.64	96.96	13.96
Family: Stephanodicaceae				
Cyclotella comata	6.48	5.82	37.71	5.43
Cyclotella atomus	7.40	3.30	24.42	3.52
Cyclotella ocellata	6.48	4.55	29.48	4.24
Cyclotella opeculata	8.33	8.01	66.72	9.61
Family: Coscinodiscaceae				
Cosinodiscus lacustris	6.48	5.82	37.71	5.42
Family: Pinnulariaceae				
Pinularia sp	7.40	6.76	50.02	7.20
Family: Fragilariaceae				
Synedria tabutata	7.40	10.22	75.62	10.89
Synadria ulna	3.70	1.72	6.36	0.92
Fragilaria venecens	5.56	3.77	20.96	3.02
Fragineria capusina	6.48	4.56	29.54	4.25
Family: Tabellariaceae				
Tabellaria flocullosa	6.48	6.45	41.79	6.02

Table 2: Stomach content of *Sardinella maderensis* (13.0cm-13.5cm)

Food Item	%RF	%Point	IFS	%IFS
Family: Melosiraceae				
Melosiradistans	7.52	12.02	90.39	13.48
Melosiravarians	6.77	10.64	72.03	10.74
Melosira italica	6.77	8.72	59.03	8.81
Melosiragranulata	7.52	7.71	57.98	8.65
Family: Stephanodicaceae				
Cyclotella comata	6.02	3.21	19.32	2.88
Cyclotella atomus	6.02	5.69	34.25	5.11
Cyclotella ocellata	5.26	6.61	34.76	5.18
Cyclotella opeculata	6.02	6.15	37.02	5.52
Family: Coscinodiscaceae				
Cosinodiscuslacustris 7.52	6.33	47.60	7.10	
Family: Pinnulariaceae				
Pinularia sp	6.77	6.51	44.07	6.57
Family: Fragilariaceae				
Synedria tabutata	6.77	7.61	51.52	7.68
Synadria ulna	6.77	6.42	43.46	6.48
Fragilaria venecens	6.77	5.13	34.73	5.18
Fragineriacapusina	5.26	3.11	16.36	2.44
Family: Tabellariaceae				
Tabellariaflocullosa	6.77	4.12	27.89	4.16

DISCUSSIONS

With a growth coefficient of 2.4767±0.0619 *Sardinella maderensis*clearly had a negative allometric growth. This indicates a fish that gets slender as it grows. Such growth could be influenced by intrinsic and extrinsic factors. Where intrinsic factors are majorly responsible, growing such species in captivity may not bring many returns in terms of feed conversion ratio. Should extrinsic factor be the major reason behind the negativity of the allometry, then good culture techniques and water quality management may help produce desired results. The observed condition factor (2.2194±0.14903) was above one as such indicating I fish that is optimum in wellbeing. This could indicate that the fish has a good water quality condition and food supply .

The gut content of the fish shows a fish that selectively fed on phytoplankton, comprising of six families and fifteen species. Availability and choice are two major factors that could influence the food uptake of organisms. Furthermore, some species change feeding habit and food choices as they grow, but *Sardinella maderensis* did not show any shift except for the most consumed item for the different classes that showed some variation *Melosiragranulata* for the small class and *Melosiradistans* for the larger class.

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